Masters Theses 1911 - February 2014

1955

A study of inexpensive equipment for junior high school science experiments.

Edward J. Bourdeau
University of Massachusetts Amherst

A STUDY OF INEXPENSIVE EQUIPMENT FOR JUNIOR HIGH SCHOOL SCIENCE EXPERIMENTS

BOURDEAU - 1955

A STUDY OF INEXPENSIVE EQUIPMENT FOR JUNIOR HIGH SCHOOL SCIENCE EXPERIMENTS

by

Edward J. Bourdeau

A problem submitted in partial fulfilment
of the requirements of the Master of
Science Degree

University of Massachusetts

1955

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

CHAPTER I

HISTORY AND BACKGROUND

CHAPTER I

HISTORY AND BACKGROUND

About two decades ago it became clear to educators that the highly refined and intensive special sciences did not provide the best introductory courses in high school. Several independent experiments were started in the effort to discover the kinds of subject, organization, and presentation which would be of greatest educational value. Unprecedented numbers of young people were, and still are, coming into modern high schools. Most of these wanted and needed a good general science background, which might or might not be followed by further work in high school or by later science studies in college. Such a course was developed under the name of general science, and it has succeeded in encouraging educators who genuinely desire to improve American education. Furthermore, the success of this course has resulted in improvement in other courses in science and has thus helped science-teaching in general.

A Federal Security Agency bulletin published in 1950[1] indicates the acceptance of the general science course in the United States school systems. In the year 1922, only 18.27 per cent of the ninth-grade pupils enrolled in general science courses, while in the year 1947-48, the per cent of students taking ninth-grade science was 66.2. The bulletin indi-

---

(1) Johnson, Philip. "The Teaching of Science in Public Schools". Federal Security Agency Bulletin. Volume 9, p. 6.

cated that during the first term of the school year 1947-48 in the schools having a seventh grade, 61.6 per cent of the pupils in that grade were enrolled in seventh grade general science. The corresponding figure for the eight-grade is 78.4 per cent.

In the same bulletin some ideas were also given of the problems confronting those who wish to provide such a course for their students. In the list of troublesome problems related to science teaching, the more frequently mentioned were those having to do with teaching staff, adequate science rooms, and, heading the list, supplies and equipment. The supply and equipment problem was listed by 261 out of 782 high schools in the sample. It is evident an economical solution to the problem of supplies and equipment would further the entire structure of general science teaching, and it is to such a solution that this research is directed.

Science has changed a great deal from 2200 years ago, when one of the world's greatest thinkers, Aristotle, noticed that a light object, such as a feather or a piece of paper, falls slowly to the ground, while a heavy object falls much faster. He pondered on this and concluded that heavy things fall faster than light things; that is, a ten-pound weight would fall ten times as fast as a one-pound weight. Having decided this in his mind, he taught it as a truth to his students. Because he was Aristotle, the wise man, his students believed him. One might think that Aristotle would have experimented to see if his theory was correct. But he did not do so. The early scientist rarely thought of experimenting. He would see something happen; then he would think about it and decide what it was or why it happened. But he rarely thought of testing an idea to see whether it was true.

It was a great advance for science, when an Italian, named Galileo, doubted some things that the great Aristotle had said. Galileo was a different kind of thinker. He was not sure of his theories until he tested them. He disproved the theory that heavier objects fall faster than lighter objects. To disprove Aristotle's theory, Galileo on several occasions dropped two objects of different weights from the top of the leaning tower in the city of Pisa. This was the beginning of science experiments.[2]

Many other important men since then have supported the idea of experimentation in education.

Comenius advocated: " let children learn to do by doing, by their own activity and experience".[3]

John Dewey remarked: " An experience, a very humble experience, is capable of generating and carrying any amount of theory, but a theory apart from an experience cannot be defi-

---

(2) Beauchamp, Wilbur L., Mayfield, John C., West, Joseph Y. Everyday Problems in Science. 1940. p. 5.

(3) Mulhern, James A History of Education. 1940. p. 271.

nitely grasped even as a theory".[4]

Friedrich Froebel, in 1826, stated: " To learn a thing in life and through doing, is much more developing, cultivating, and strengthening than to learn it merely through the verbal communication of ideas".[5]

Paul F. Brandwein wrote: " Most school systems in the country have planned or are planning for a general science experience in the junior high-school years, the seventh, eight, and ninth grades. Throughout the country there are also "spots" of general science offerings in the tenth, eleventh, and the twelfth grades".[6]

Robert Stollberg stated that: " A modern view among science educators is that both the laboratory experience and the classroom demonstration have their rightful place in the junior high school science program. A considerable body of research has failed to reveal that either teaching technique is so inferior to the other as to justify abandoning it". He also stated: " Continued emphasis on general education provides a constant reminder of the old but worthy maxim that ' we learn by doing '. Science learning in the laboratory, when properly carried on, is a high order of ' learning by doing', and we find that modern educational psychology thus

---

(4) Mulhern, James. op. cit. p. 73.

(5) Ibid. p. 378.

(6) Brandwein, Paul F., The Bulletin of the National Association of Secondary-School Principals. 1953. p. 51.

strongly supports the laboratory as a tool of science education".[7]

It is apparent that the laboratory method, considered essential by the above educators in teaching general science, has been augmented through the medium of television. Evidence of the important role to be played by television in education is the successful efforts throughout the United States that have been made to reserve certain channels for educational television. However, commercial television apparently recognizes the appeal of educational programs. In no field is this more to be noted than in that of science, for at the present time several hours weekly are devoted to programs dealing with science in general. Among these shows are: "Hopkins Science Review", "American Industry", "Calvacade of America", "Zoo Parade", and "Doctor Wizard". Although all of these programs present a great range of scientific subjects in terms easily understood by youngsters of junior high age, the last named one is particularly appropriate for this group. A program like "Doctor Wizard" which has many experiments illustrating scientific principles is much more entertaining, educational, and popular with the younger audience than the traditional method of lecturing.

Educators through the years have emphasized the need for laboratory experiments in the classroom. Undoubtedly such

---

(7) Brandwein, Paul F., op. cit. p. 101.

experimentation would enhance the general science curriculum of any school system. However, with supplies and equipment not available in many of the smaller schools, improvisation is necessary to carry out a successful and varied course in general science. The author realizing the importance of this problem, will attempt to devise adequate substitutes for expensive commercial products.

CHAPTER II

GUIDEPOSTS FOR SCIENTIFIC EXPERIMENTS

CHAPTER II

GUIDEPOSTS FOR SCIENTIFIC EXPERIMENTS

Experimenting is one of the important ways to learn science principles and procedures. Thoughtful consideration of this idea ought to indicate to the teacher what should be the relation between the pupil and the school laboratory. It ought to be clearly understood that the student should go there not to "do stunts" but to find out first hand by special-personal observations and experiments certain essential facts which he needs to solve a problem in science or to understand certain equipment necessary for everyday living.

The function of the teacher is to lead, inspire, and guide the pupils. The good instructor avoids too much telling, often answers one question by asking another, or directing the student to a reference book where he can get the required information for himself.[8]

Certain guideposts for good experimenting are essential to consider if pupils are to realize to the fullest measure the potentialities to be derived from this way of learning.

The following criteria will be useful guides in the selection of scientific experiments:[9]

1. A project for the laboratory should provide the

---

(8) Twiss, George R., A Textbook in the Principles of Science Teaching, 1933, p. 127.

(9) Ibid. p. 131.

essential steps for answering some question or questions that are involved in the solution of some problem that is significant to the students.

2. It should have some direct and clear connection with what immediately precedes and follows it in the course.

3. It should be one that compels careful observation.

4. There should not be so many things to observe or do that mental confusion will result.

5. It should be so easy of manipulation that the poorest qualified of the students can do the work with fair success and reasonable speed.

6. It must be capable of being done by the students with a reasonable degree of accuracy; and such reasonable accuracy should be insisted on, else the students will have no faith in it nor in what it is intented to teach.

7. Wherever practicable the parts of the experiments should be so arranged that the results obtained in them will check one another, thus enabling the students to judge their accuracy by the agreement among the results themselves instead of by comparison with the results in the book.

8. The reasoning involved in reaching the conclusions must be simple and direct enough to be made by the students themselves with very little assistance.

9. It must involve no more operations than the average worker can finish without hurry and confusion in the laboratory period. If the period be but forty-five minutes long,

the operations can, in some cases be divided between two periods; in other cases the operation may be divided among individuals of small groups of students and the results collated for each group and compared in the classroom.

CHAPTER III

STATEMENT OF PROBLEM AND OUTLINE OF PROCEDURE

CHAPTER III

STATEMENT OF PROBLEM AND OUTLINE OF PROCEDURE

The Problem -- Among the many problems that confront the teacher in the presentation of science topics is the lack of apparatus of even the simplest type due to the high cost of equipment. The teacher finds it embarrassing to use the well-known excuse, "I do not have the tools". Instead he struggles to do the best he can with little or no equipment. This problem is concerned with some very simple but basic pieces of equipment that may be made by the teacher or pupils. Some of these pieces of homemade apparatus can be used repeatedly for many different types of experiments or demonstrations.

Procedure -- The first objective in working on this problem was the selection of a series of main topics, using text books and courses of study as a guide as shown in Tables I and II. An examination of these sources indicated that though the books and courses differ in treatment and presentation, they agree in general on the topics that pupils in grade seven, eight, and nine should take up in general science.

The next step was to get information on experimental and demonstration equipment and procedures which would serve to illustrate some of the scientific principles taken up in dealing with these topics. Several sources which proved fruitful in obtaining the desired information, were the following:

1. Companies such as Westinghouse and General Electric provided material on types of ready made equipment for classroom use in demonstrations and experiments.

2. Articles were obtained from popular science magazines, such as "Science Illustrated" and"Popular Mechanics".

3. Instructive cartoon books like "Fun in Science" provided an excellent source on improvised experimentations.

4. Advertising material from science equipment dealers was also used.

5. Companies such as Welsh Scientific Company, Fisher Scientific Company, and Baker Chemical Company provided information on commercial equipment.

The final step was to select inexpensive substitutes to replace the commercial equipment, As a result of thought and experience, supplemented by that of other teachers in the Western Massachusetts area who gave generous aid, the substitute experiments were selected.

After selecting from these sources a number of demonstrations and experiments relative with the topics listed in Tables I and II, each one was tried and a photograph was taken of the piece of equipment, the experiment itself, or the result. In addition, photography was used as a supplement to describe the more expensive equipment which in each case could be used if financial aid was not limited.

Following is a list of city courses of study that were used as a basis in the selection of science topics. Courses of study from the following cities:

1. Greenfield Junior High
2. Malden High School
3. Lawrence Junior High (Holyoke)
4. Northampton Junior High
5. Boston School System (7) Schools
6. Turners Falls Grammar School

Following is a list of standard text books that were consulted:

1. Text: "Science for Better Living"
   Authors: Leland Hollingsworth
   Paul Brandwein
   Alfred Beck
   Anne Burgess
   Publisher: Harcourt Company
   Date: 1950
2. Text: "Science in Daily Life"
   Authors: Francis Curtis
   George Mallinson
   Publishers: Ginn and Company
   Date: 1953
3. Text: "The Physical Sciences"
   Authors: Charles Waugh
   Herbert Welsh
   Burdette Buckingham

Publishers: Ginn and Company

Date: 1950

4. Text: "Science a Story of Discovery and Progress"

Authors: Ira Davis

John Burnett

Wayne Cross

Publishers: Henry Holt and Company

Date: 1952

5. Text: "Our Environment"

Authors: George Wood

Henry Carpenter

Publishers: Allyn and Bacon

Date: 1946

6. Text: "New Senior Science"

Authors: Will Thompson

George Bush

Publishers: American Book Company

Date: 1954

The ten topics were selected on the basis of the answers received from the thirteen schools, listed above, regarding the science curriculum as topics taken up by their pupils. Also, of the modern science text books that were consulted, the only exceptions in the listing of sections dealing with these topics were as follows:

1. One book--no chapter on sound.

2. One book--no chapter on food.

3. One book--no chapter on machine.

4. One book-- no chapter on transportation.

5. One book-- no chapter on health.

However, each of these texts deal with these topics, though not as separate chapters. As a result of this information, the selection of topics seemed justified.

TABLE I

Topics That Are Covered By Certain Junior High Schools

Topics	Lawrence	Northampton	Greenfield	Malden	Montague	Boston
Air	X	X	X	X	X	X
Water	X	X	X	X	X	X
Fire	Z	X	X	X	X	X
Heat	X	X	X	X	X	X
Electricity	X	X	X	X	X	X
Magnet	X	X	X	X	X	Y
Sound	X	X	Z	X	X	Y
Health	Y	X	[illegible]		X	X
Food	Y	X	[illegible]	X	X	X
Light	X	X	X	X	Y	X
Weather	X	X	X	X	Y	X
Transportation	X	X	Z	X	Y	X

X-Main Topic Y-Sub Topic Z-Optional

TABLE II

Topics Covered By Certain

Text Books

Topics	New Senior Science	Science for Better Living	Science in Daily Life	Science Discovery Progress	Our Environment	Physical Sciences
Air	Y	Y	X	X	X	X
Water	Y	Y	X	X	X	X
Fire	X	Y	Y	X	X	Y
Heat	Y	Y	X	X	X	X
Light	X	X	X	X	X	X
Sound	X	X	Y	X	Y	X
Magnetism	Y	X	Y	X	X	X
Food	X	X	Y	X	X	X
Electricity	X	X	X	X	X	X
Health	Y	X	Y	X	X	X
Weather	X	X	X	X	X	X
Transportation	X	X	X	X	X	X

X-Main Topic

Y-Sub Topic

CHAPTER IV

EXPERIMENTS

Topic: Air.

Object: To show that air pressure varies from time to time.

Importance: The barometer has made possible the modern science of forecasting the changes in the weather for days ahead. This instrument is also used in measuring how high a plane is flying above sea level and the height of mountains.

Pictures:

Commercial

School made

Materials: Wide mouth bottle, Glass tubing, One hole stopper, Wax, Colored water

Approximate Cost: One dollar.

Procedure: Place colored water in a wide mouth bottle and then place tubing through the one hole stopper. Set stopper into the bottle and arrange glass tubing so that the end is submerged beneath the water. Cover the cork with wax so that air cannot penetrate it.

Comparison: The home-made barometer has the following limitations:

1. The substitute is not as accurate as the commercial product.
2. It cannot be placed outside during freezing weather.
3. Temperature will have a small effect upon it.
4. It cannot be used as an altimeter.

Topic: Air.

Object: To show that air exerts pressure.

Importance: Air pressure makes it possible to drink through a straw. Air pressure makes the siphon possible. It also makes pneumatic tires possible.

Pictures:

Commercial School made

Materials: Newspapers

Piece of wood
4' long
2" wide
1/8" thick

Approximate Cost: None.

Procedure: Place a strip of wood on a table so that approximately four inches project over the edge of the table. Placing three double sheets of newspaper over the strip of wood that is resting on the table, one should be careful that the newspapers hug the stick and table closely. Next, strike the stick a hard swift blow with the fist. To the amazement of everyone the wood will break in half while the papers are still resting in position on the table.

Comparisons: 1. With the bell jar the students can lift the bell jar off the exhaust pump and then attempt it after air has been exhausted from the jar.

2. Due to its simplicity the paper and board is a more dramatic experiment and will create a longer impression on the pupil.

3. The bell jar adapts itself to greater variety of use than the school-made apparatus.

Topic: Air.

Object: To show how balls curve when ball-players, tennis players, and golfers put a spin on the ball.

Importance: This fact plays an important role in the winning of many athletic contests.

Pictures:

Commercial School made

Materials: Ping pong ball String

Approximate Cost: Ten-cents.

Procedure: First draw the ball back, as shown in the photograph, and let it go. It swings normally, straight back and forth. By twisting the string about fifty twists to the left, the ball will spin clockwise when released. Let it go again. The ball will curve decidedly to the right, tending to twist more and more to the right as it swings.

Comparison: With the ping pong ball the students can get a much better understanding of Bernoulli's principle, because the ping pong ball can clearly be seen moving into the fast moving air.

Topic: Air.

Object: To demonstrate Bernoulli's Paradox which is one of the most important principles of aerodynamics.

Importance: This principle enables one to make use of air transportation, insect sprayers, and atomizers.

Pictures:

Commercial School made

Materials: Vacuum cleaner Ping pong ball

Approximate Cost: Ten cents.

Procedure: Turn on an electric fan or vacuum cleaner and point it upward. Into the steady stream of air drop the ping pong ball. The ball will bob up and down, but it will not leave the stream because of the area of high speed low-pressure air flowing around it.

Comparison: Since it is impossible to use an airplane or like apparatus in the classroom. This demonstration will enable the students to get a much clearer view of the effect that the speed of air has on air pressure.

Topic: Air.

Object: To show that air exerts pressure.

Importance: The use of air pressure around the home has helped to make life easier for the home-maker through the following devices, among others: vacuum cleaner, water pump, fountain pen, and medicine dropper.

Pictures:

Commercial School made

Materials: Gallon can Stopper

Water

Approximate Cost: None

Procedure: Fill the can with one-quarter of an inch of water. Place can over heat and boil water violently for several minutes. Then remove can from heat and place stopper on tightly.

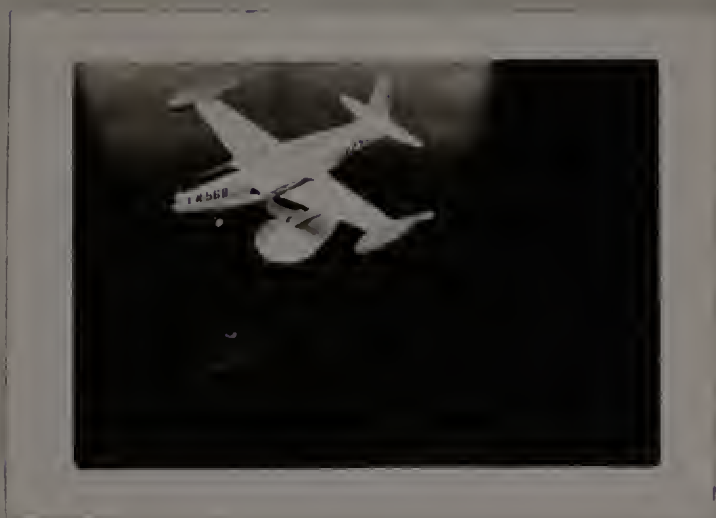
Comparison: The commercial and school made product produce the same results.

Topic: Air.

Object: To show Bernoulli's principle that fast moving air exerts less pressure than slower moving air.

Importance: Without the use of air-pressure our aircraft would not be able to remain in the air.

Pictures:



Commercial — School made

Materials: Book — Sheet of paper

Electric fan

Approximate Cost: None.

Procedure: Place a sheet of paper in a book as shown. Let the free end of the paper bend over the book and drop towards the table. Turn the fan on and direct the fast moving air over the top of the paper. The paper will rise and flutter out straight.

Comparison: Without the school made demonstration this scientific principle cannot be done in the class room.

Topic: Air.

Object: To show that air exerts pressure.

Importance: Air pressure is used in operating a door check or when a car is being lifted onto some forms of hoists.

Pictures:

Commercial School made

Materials: Milk bottle Kleenex

Egg Matches

Approximate Cost: Ten cents.

Procedure: Set pieces of Kleenex on fire and drop them into bottle until air is warm enough to expand. Immediately place a hard boiled egg in the mouth of the bottle.

Comparison: The hemisphere disk can be used as a tug of war. By turning the valve, air can be heard rushing into the partial vacuum. Through experience the bottle and egg demonstration will create a longer impression upon the student.

Note: To remove egg tip bottle upside down and blow air into milk bottle to build up pressure inside and then release to let egg pop out.

Topic: Heat.

Object: To show the principle of convection current.

Importance: Water is heated by the use of the convection current, and it is the principle by which hot air and hot water heating systems work.

Pictures:

Commercial

School made

Materials: Shoe box | Two candles
Burning splinter | Two glass tubes

Approximate Cost: Twenty cents.

Procedure: Cut two holes in the side of the box that are smaller than the size of the glass tubes. Set the chimney over the holes. Place a candle under one of the holes and light it. Place glass in front of the shoe box and observe the smoke that is coming from the glowing splinter which has been placed over the chimney. Try placing glowing splinter over the other chimney and observe the results.

Comparison: In addition to showing convection current, the school made apparatus can be used to show how a room can be best ventilated, by drilling holes at both ends of the box. By placing corks in the holes, one can set up different situations of ventilating a room.

Topic: Heat.

Object: To prove that white reflects heat while dark absorbs it.

Importance: This is of great importance in the heating of homes and determining the type of clothing a person wears in the various seasons.

Pictures:

Commercial

School made

Materials: Tin can

Paint

Light bulb

Approximate Cost: Fifty cents.

Procedure: Paint one half of the tin can black. Place a light bulb in the can and turn on the light. Place hands around the can and determine which side of the can is warmer.

Comparison: The commercial product is much more sensitive than the home made apparatus.

Topic: Heat.

Object: To prove that materials expand when heated and contract when cooled.

Importance: Because of this fact, railroads, telephone companies, and many other businesses must make an allowance for the expansion and contraction of metals.

Pictures:

Commercial School made

Materials: Bolt Nut

Approximate Cost: Ten cents.

Procedure: Pass the head of the bolt through the head of the nut several times. Next hold the head of the bolt over the flame for a few minutes. Again try to pass the head of the bolt through the nut. Cool the bolt and attempt to pass it through once more.

Comparison: The commercial and school made product produce the same result.

Topic: Heat.

Object: To prove that hot air weighs less than cold air.

Importance: The heating of our homes is made possible by hot air rising and cold air falling. Certain storms are formed by cold air falling and warm air rising.

Pictures:

Commercial

School made

Materials: Two paper bags
String
Yard stick

Approximate Cost: None.

Procedure: Attach string to the bottom of each bag with transparent tape. Tie other end of the string to the yard stick. Balance the stick on its edge while it is tied to another piece of string. Holding one of the bags lightly with the fingers, hold lighted candle in the paper bag. Scale tips in direction of cold bag, after heating the air of the other bag.

Comparison: It is much safer to use empty tin cans because of the danger of setting the paper bags on fire. It is, however, possible to fire proof the paper bags.

Topic: Heat.

Object: To show that certain metals conduct heat faster than others.

Importance: By the use of conduction it is possible to cool our foods, boil water, and heat many other objects.

Pictures:

Commercial

School made

Materials: Piece of wood

Metal strips

a. copper   d. aluminum

b. steel   e. brass

c. iron

Approximate Cost: None.

Procedure: Cut all of the metal strips the same length and diameter. Place all ends together and fan out the strips on the board. Fasten them to the board so that they cannot move. Place parafin on the end of each piece of metal. Heat the metal strips at the vertex.

Comparison: The commercial and school made product produce the same results.

Topic: Fire.

Object: To show how one may fire proof material.

Importance: Many times, for safety purposes, it is wise to fire proof materials that are used for stage props, curtains, lamp shades, and many other things.

Pictures:

Commercial School made

Materials: Borax Boric acid

Cloth

Approximate Cost: One dollar.

Procedure: Make a solution of one ounce borax and three-fourths of an ounce of boric acid, both in crystal form, and dissolve in one pint of water. Soak one piece of cloth in the solution and allow it to dry. Attempt to set on fire the treated cloth and also the untreated piece of cloth.

Comparison: The commercial product as well as the school made product has to be treated after every washing or whenever the fire proof material has been thoroughly wet. The commercial and the school made products produce the same results.

Topic: Fire.

Object: How to put out a fire by the use of carbon dioxide gas.

Importance: Carbon dioxide is the agent used in some common fire extinguishers. It will not support combustion and being heavier than air it will settle to the ground.

Pictures:

Commercial

School made

Materials: Baking soda, Water, Cardboard, Vinegar, Glass, Candle

Approximate Cost: Ten cents.

Procedure: Mix about a teaspoonful of baking soda, a glass of water and then add vinegar. Although carbon dioxide gas is invisible it settles to the ground because it is heavier than air. Immediately after the vinegar is added pour the gas down a cardboard slide which is placed above the lit candle.

Comparison: The commercial and school made product produce the same results.

Topic: Fire.

Object: To show how the chemical reaction starts in a soda-acid fire extinguisher.

Importance: Every school student should be able to operate a fire extinguisher as soon as possible because the safety of his school or home may depend upon his ability to operate one.

Pictures:

Commercial

School made

Materials: Bottle — Small bottle

Vinegar — Glass tubing

Baking soda — One hold stopper

Approximate Cost: Fifty cents.

Procedure: Pour a solution of water and baking soda into a bottle that is going to be used as the fire extinguisher. Fill the small bottle with vinegar and suspend it in the large bottle as shown. To set the extinguisher in action turn the bottle, upside down.

Comparison: The school made project will give a much clearer picture of the chemical reaction that takes place when the glass bottle is tipped upside down. This view is not possible with a commercial extinguisher.

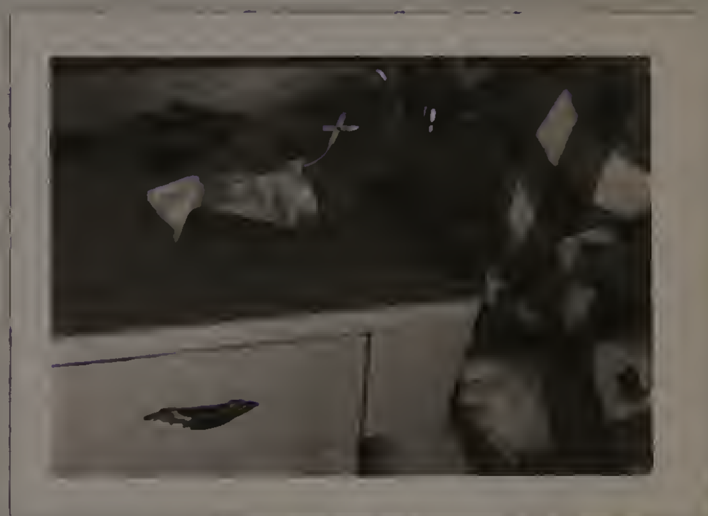
Topic: Fire.

Object: How to put out an oil fire. Water will not put it out.

Importance: It is very important that water should not be used to put out oil fires because water, which is heavier than oil, causes the oil to float on the surface.

Pictures:

Commercial



School made

Materials: Fire proof cloth.

Approximate Cost: None.

Procedure: Fill a glass almost to the top with water and then sprinkle lighter fluid on the water. Place the glass on a piece of fire proof material. Set the lighter fluid on fire and observe the severe fire. By completely covering the fire, one can extinguish it very easily. This can be done with any fire proof material.

Comparison: This demonstration can only be done on a small scale. Students will readily see that water will not extinguish the blaze, and when one completely covers the fire it immediately goes out. The commercial and school made product produce the same results.

Topic: Water.

Object: To show the distillation of water.

Importance: Science and medicine rely heavily on chemical formulas which use distilled water. Passengers aboard ocean liners make use of distilled water for drinking purposes.

Pictures:

Commercial | School made

	Commercial	School made
Materials:	Flask	Test tube
	Glass tubing	Ice
	Stopper	

Approximate Cost: Twenty cents.

Procedure: Pour a quantity of muddy, salty, or colored water into the flask. Put the end of the delivery tube so that it is surrounded by cold water. Heat the flask slowly until an inch or so of distilled water is in the test tube.

Comparison: The commercial and the school made product produce the same results.

Topic: Water.

Object: To show the principle of osmosis.

Importance: Plants must take in water in order to grow. They do this by a peculiar process called osmosis. Food is passed through certain membranes by the process of osmosis in the digestion of foods.

Pictures:

Commercial

School made

Materials: Glass	Egg
Water	Glass tubing
Wax	

Approximate Cost: Twenty cents.

Procedure: Without breaking the inner membrane of an egg, carefully puncture a small hole in the shell. At opposite end of the egg puncture a smaller hole through the shell and membrane of the egg. Cover this small hole with glass tubing and hold in place with wax. Submerge the other end of the egg in a glass of water and allow it to stand.

Comparison: Substitute product though very delicate, more dramatically demonstrates the process, and through use of a familiar household object catches the attention of the student.

Topic: Water.

Object: To show the Town of Montague's water supply system.

Importance: To educate the children on how valuable a water supply system is to any community, also, the reason why we have such good drinking water and excellent pressure.

Pictures:

Commercial

School made

Materials: Laboratory sink	Tripod
Model house	Glass tubing
Tall wax can	Small lift pump
Filter bed	

Approximate Cost: None.

Procedure: Fill the sink with water and sprinkle sand into the water to make it cloudy. With the model lift pump, pump the dirty water from the sink into the model filter bed which is located in front of the purification plant. The water that is passing through the filter bed is allowed to drain into a large beaker so that the students can see how clear the water is after it is filtered. The water is pumped once again to Mills Hill which is represented by a tall wax can which has the bottom cut off. The bottom is plugged by a one hole stopper that has rubber tubing in the hole. A clamp is placed on the tubing to prevent the water from running out of the can. On the side of the can have three holes, at the bottom, half way up the can, and three quarters up the can. These holes are plugged up by placing rubber against the holes on the inside of the can. Water pressure will press the rubber so tightly against the sides that the water will not be able to leak out of the container. By removing one piece of rubber at a time one can show how the height of water controls water pressure. The deeper the water, the greater the pressure. With the rubber tubing one can place the end of the tube at different levels of the model, and by opening the clamp, the students can see that the pressure of the water is greater at the hospital than it is at the school.

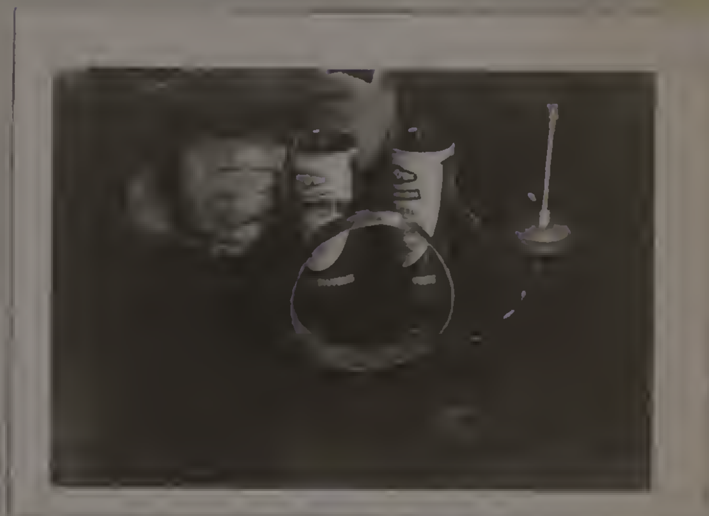
Comparison: No commercial product.

Topic: Electricity and Magnetism.

Object: To show how a galvanometer is built.

Importance: It is a delicate instrument which is used to detect an electric current and to measure its strength.

Pictures:



Commercial School made

Materials: Wire Needle

Dry cell Cardboard

Approximate Cost: Twenty cents.

Procedure: Wrap approximately 25 turns of bell wire around a cardboard cylinder. Then suspend a magnetized needle on a thread inside of the cylinder. When one touches the coil of wire to the pole of a dry cell, the needle will swing around, indicating that an electric current is flowing.

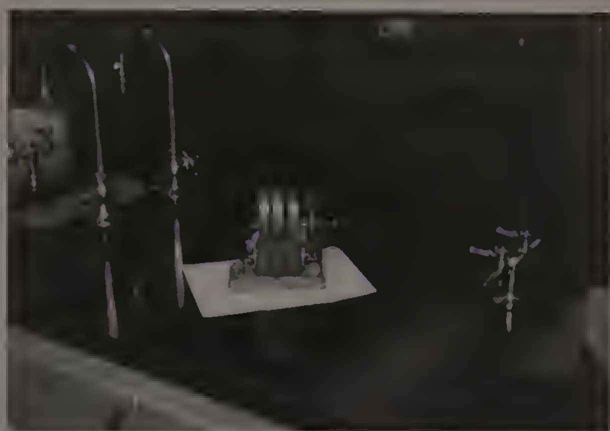
Comparison: The two advantages of the commercial product are that it is more sensitive and registers numerically the strength of the charge.

Topic: Electricity and Magnetism.

Object: To show how an electric-generator is built.

Importance: A machine used to change mechanical energy to electrical energy.

Pictures:



Commercial School made

Materials: U shape magnet Home made galvanometer

Approximate Cost: Fifty cents.

Procedure: Wind approximately 100 turns of bell wire around cardboard and connect to galvanometer, described in preceding experiment. Then move a permanent magnet up and down inside of the coil. Each movement of the magnet generates a weak electrical current, causing magnetized needle in galvanometer to move.

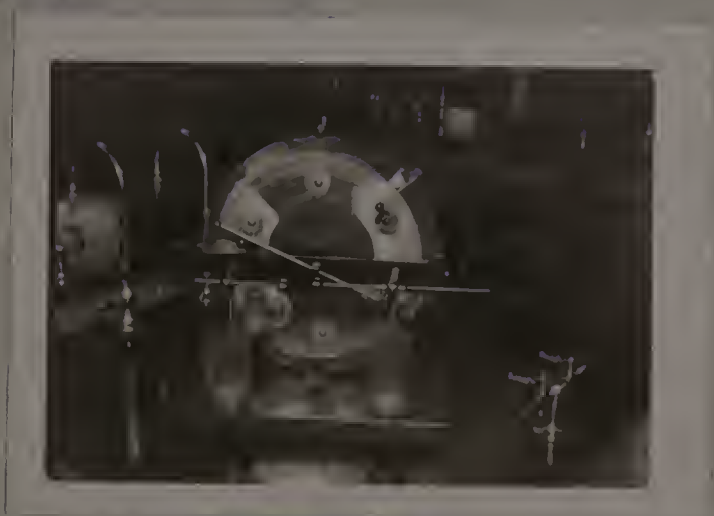
Comparison: Both the commercial and school made product produce the same results.

Topic: Electricity and Magnetism.

Object: To show how one produces static electricity.

Importance: By producing static electricity it is possible to break up particles of the atom and understand the phenomena of thunderstorms. Static sparks in industry, grain elevators, gasoline trucks, and machine belts are very dangerous because of the possibility of fire.

Pictures:



Commercial

School made

Materials: Comb Water

Approximate Cost: None.

Procedure: Running a comb briskly through ones hair about ten times and then hold it near a fine stream of water. The water will bend toward the comb.

Comparison: One can produce a greater static charge with the commercial product. This enables one to store up a large charge of static electricity.

Topic: Electricity and Magnetism.

Object: To show how an electric motor is built.

Importance: The electric motor changes electric energy into mechanical energy to perform work. Motors are used in all kinds of work from the simple operation of using a vacuum cleaner to letting down the heavy landing gear of a huge airliner.

Pictures:

Commercial   School made

Materials: Roll of tape   Wood

3-4 inch nails (20 penny)   Two tacks

4-2½ inch nails (8 penny)   Two dry cells

4-3 inch nails (10 penny)

Approximate Cost: One dollar.

Procedure: For armature shaft wrap 1½ inches of four inch nail with two layers of tape. For the armature core, tape two pairs of 2½ inch nails alternately head and point. Center the cores on each side of the armature shaft about one inch from the head of the shaft. Wrap the cores with two layers of tape from head to point. Wind armature with two layers of wire. Start at the shaft, wind out and back half of the core. Always wind in same direction. Leave about six inches of wire at start and finish.

For the field bend two four inch nails in center for field core. Space heads of nails about three inches apart and wrap nails together with two layers of tape. Wrap the field core with about 400 turns of wire. Leave three inches of wire at the start and finish. Attach the field to wood base with staples.

To form the commutator, bend the bare wire ends back and lay them against the armature shaft half way between the armature coils. Hold the commutator down with narrow strip of tape.

For armature support, drive four 3-inch nails in base, locating them so that the armature turns exactly between field poles. Wrap wire around armature support to form armature bearings.

Comparison: The more expensive standard product is more powerful and speed can be easily regulated by a dial. On the other hand the home made product can be demonstrated more directly to the student since the parts are in view.

Topic: Electricity and Magnetism.

Object: To show how an electroscope is built.

Importance: One of the most important uses of the electroscope is the detection of radium when lost in hospitals. It also can detect the presence of an electric charge.

Pictures:

Commercial School made

Materials: Wide mouth bottle Cork

Aluminum foil Penny

Approximate Cost: Twenty cents.

Procedure: The procedure is to solder the penny to one end of the wire and then push the wire through the cork. One should make a right angle bend in the wire about one-half inch from the lower end. After cutting a strip of foil about one-quarter of an inch wide and two inches long, hang it near its center over the bent portion of the wire. A drop or two of finger nail polish will stick it fast to the wire. The last step is to place the whole assembly in the bottle to protect it.

Comparison: The commercial and school made product produce the same results.

Topic: Electricity and Magnetism.

Object: To show that the earth has an effect upon a compass.

Importance: This discovery made possible the invention of the compass. It is now possible for sailors to tell in which direction they are sailing, even in a storm when they can not see the stars.

Pictures:

Commercial

School made

Materials: Bowl

Cork

Water

Needle

Approximate Cost: None.

Procedure: A floating compass is easily built by attaching a magnetized needle to a cork in a bowl of water.

Comparison: This process is more dramatic for the student, since it would seem a more unusual procedure than simply using a compass, which is a familiar object to nearly all youngsters.

Topic: Electricity and Magnetism.

Object: To show how an electromagnet is built.

Importance: The electromagnet is the foundation of nearly all electrical machines, such as electric motor and dynamo. Junk yards and steel mills make use of this device.

Pictures:

Commercial School made

Materials: Iron core Wire

Two dry cells Paper clips

Approximate Cost: Ten cents.

Procedure: Using an iron core wrap approximately one hundred turns of ordinary bell wire evenly around the core. Attach the wire to the dry cells. With this simple electromagnet, one can pick up nails or magnetize needles.

Comparison: A commercial electromagnet is more powerful but has no classroom advantage. Both commercial and school made product produce the same results.

Topic: Electricity and Magnetism.

Object: Proving that it is possible to store up a large charge of static electricity.

Importance: Static electricity can be of great danger in the dry cleaning of leather goods, cloth, and especially silk cloth due to the danger of fire.

Pictures:

Commercial

School made

Materials: Photo film
Sealing wax
Piece of fur
Tin dish

Approximate Cost: Twenty cents.

Procedure: To make the electrophorous, heat one end of the sealing wax and attach it securely to the center of the tin disk. Charging an electrophorous is done by rubbing the photographic negative briskly with fur and placing the disk on the negative. By placing disk near ear, a clicking noise will be heard which proves that a static charge was present.

Comparison: The commercial and the school made product produce the same results.

Topic: Electricity and Magnetism.

Object: To show how a telegraph set is made and operated.

Importance: Messages sent by telegraph travel with the speed of electricity through wires or 10,000 miles per second. Important news reports and business messages can be sent across mountains and deserts, and even under the bed of the ocean.

Pictures:

Commercial

School made

Materials: Hack saw blades
Board
Screw
Six washers
Coil of wire
Curtain hook
Two spools of thread

Approximate Cost: Ten cents.

Procedure: To make the sending key, break an old hack saw blade in half and attach one piece to board by means of screw and half dozen washers, as pictured above. Put another screw under loose end of blade and your sending key is ready to connect to your telegraph wires.

For telegraph sounder, attach the other half of hack saw blade to wood spool on board, as shown. Wind about fifty turns of bell wire around small iron bolt and fasten it under opposite end of blade. Use curtain hook to connect and control upward movement of blade. By connecting the telegraph key and sounder, the instrument is ready for use. Connect the two instruments with bell wire, as illustrated. Two dry cells allow one to operate sounder several hundred feet.

Comparison: The commercial and the school made product produce the same results.

Topic: Sound.

Object: To show how a trombone produces sound.

Importance: By sliding the tube and changing the length of the air column the pitch of the note will change.

Pictures:

Commercial | School made

Materials: Pop bottles | Glass tube
Water

Approximate Cost: None.

Procedure: Fill a pop bottle about three quarters full of water. Place the glass tubing into the bottle and blow across the top of the tubing until a note is heard. Once a note is sounded move the bottle up and down and various tones will be heard.

Comparison: The commercial and school made product produce the same results.

Topic: Sound.

Object: To show how woodwind instruments produce sound of different pitches.

Importance: The notes of woodwind instruments are pitched according to the length of the air column vibrating in the instruments.

Pictures:

Commercial   School made

Materials: Soda straw   Scissors

Approximate Cost: None.

Procedure: Press one end of a soda straw together. With a pair of scissors cut off the corners of the flat end diagonally. Next, blow gently into the straw until a sound is heard and while blowing cut off small pieces from the other end of the straw.

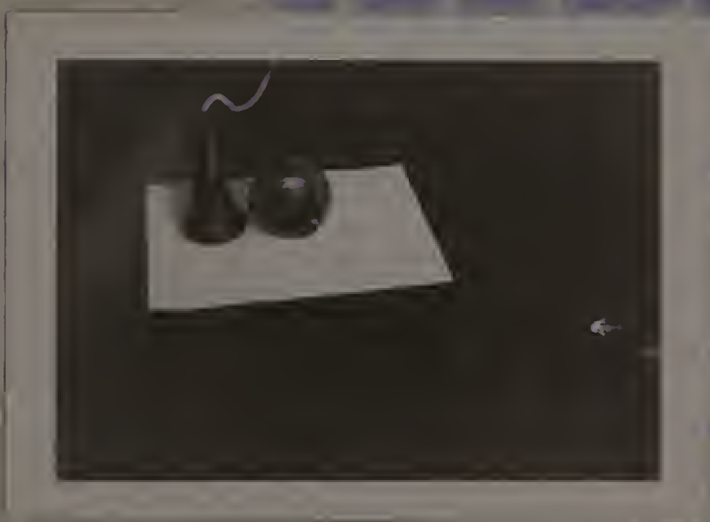
Comparison: The commercial and school made product produce the same results.

Topic: Sound.

Object: To show how a telephone works.

Importance: Today the telephone is the chief means of personal communication at a distance. In case of emergency, the telephone is a quick means of calling the doctor, the police, or the fire department.

Pictures:



Commercial

School made

Materials: Three soft lead pencils	Telephone receiver
Cigar box	Watch
Two dry cells	Copper wire

Approximate Cost: None.

Procedure: Split the lead pencils so that the lead is exposed through the whole length. On the curved sides of two of the split pencils, cut notches near both ends and deep enough to expose the lead. Have the grooves at one end wide enough to accomodate the wire. At the other end have them wide enough to accomodate the third pencil so that its lead may rest on the leads of the other two pencils.

Now sectioning the wire as necessary, connect the two pencils with the batteries and receiver as shown in the diagram. Then place the pencils flat side down on the bottom-up cigar box and lay the third pencil in place. Lay the watch on the box near the pencils and listen through the receiver.

Comparison: The commercial product in this case is more durable, as well as more sensitive. The school made product, on the other hand, can be brought directly into the classroom.

Topic: Sound.

Object: To show how a guiter produces different notes.

Importance: The stringed instrument all work on the same principle which depend on the tension, the diameter, and the speed of vibration of the strings.

Pictures:

Commercial

School made

Materials: A piece of board one foot long

Four eye screws

Wedge of wood notched for strings

Four wires or rubber bands

Cigar box

Approximate Cost: Twenty cents.

Procedure: Cut a hole about two inches square in the top of a cigar box. Attach one foot board to the top of the cigar box securely. On opposite side of cigar box attach a piece of wood to the box so that one can attach the string by means of screws or nails. After putting the wedge in place string the wires through the eye screws and the guitar is built.

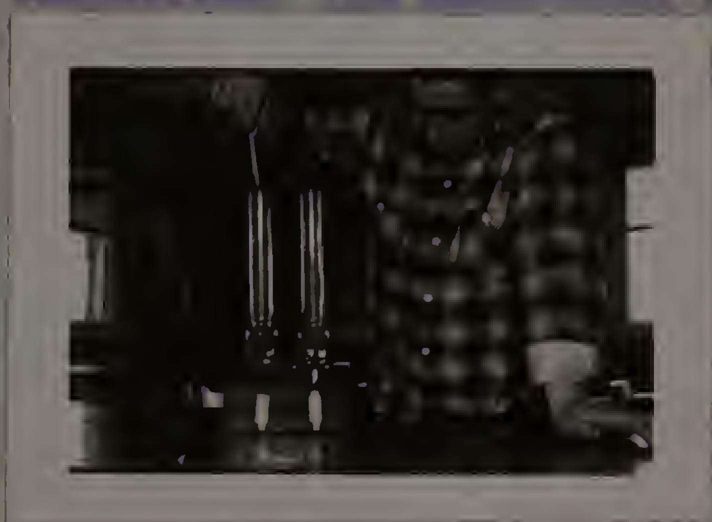
Comparison: The commercial and school made product produce the same results.

Topic: Health and Food.

Object: To illustrate the best method of ventilating a room.

Importance: Proper ventilation insures a constant supply of fresh air. Fresh air is essential to life and to the sense of well-being that comes with good health.

Pictures:



Commercial

School made

Materials: Wooden box
Limewater
Four corks
Two small candles
Piece of glass

Approximate Cost: Fifty Cents.

Procedure: A. Close all the windows and light the candles-place the limewater between them. Keep track of the time that it took the flame to go out.

B. Remove limewater, look at it, and set it aside. Open all the windows, light the candles again, and replace glass. Let candles burn for as long a time as it took candles to go out in step A ; then proceed to step C.

C. With candles still burning, close lower holes at each end, repeat time check.Watch flame closely.

D. Now open lower holes, and close upper ones, repeat time check.

E. Finally, close both holes, top and bottom at one end, leaving other side open, repeat time check.

Comparison: The commercial and school made product produce the same results.

Topic: Health and Food.

Object: To show how inexpensive it is to make soap to keep oneself clean.

Importance: Enough soap is manufactured in the United States to provide every person in the country with twenty-five pounds of soap. Some of the uses to which this soap is put are household cleaning, dish washing, hair shampoos and various other cleaning purposes.

Pictures:

Commercial   School made

Materials: Two teaspoonful of lye   Water
Melted fat

Approximate Cost: Ten cents.

Procedure: Dissolve two teaspoonful of lye in an enamel cup of water. (Being very careful not to spill any because lye burns both skin and clothing.) Heat to hasten the dissolving. Cool and add one cup of melted fat. Stir the mixture while heating it to a temperature of about 100° F., until it is fairly thick. Set the result aside and let it harden. Cut in small cakes.

Comparison: Home-made soap lacks fragrant scent of the commercial product.

Topic: Health and Food.

Object: To show how Pasteurization preserves food.

Importance: Pasteurization is a method of preserving food by alternate use of extreme heat and extreme cold to kill harmful bacteria. It is used to preserve cheese, beer, milk, and other foods.

Pictures:

Commercial

School made

Materials: Three glasses, Raw milk, Thermometer, Bunsen burner, Tripod, Wire gauze, Microscope, Petri dishes

Approximate Cost: None.

Procedure: Pour one quarter of a glass of milk in each of three glasses. Label them one, two, and three. Leave one exposed to the air for forty eight hours. Heat the milk in two glasses to a temperature of 145°F and keep it at that temperature for about twenty minutes. Boil the milk in three for about ten minutes. Place two and three with one to be examined after forty eight hours. Examine under microscope.

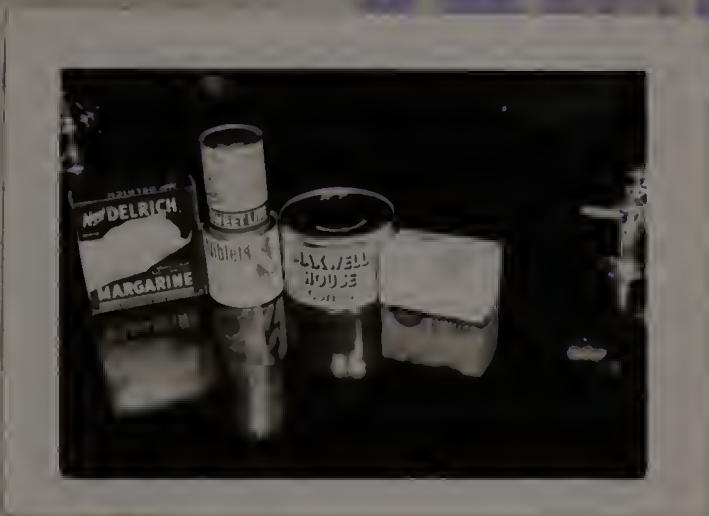
Comparison: Pasteurization equipment is too large for the classroom. This method will enable the student to observe what takes place after milk has been pasteurized.

Topic: Health and Food.

Object: To show why the Pure Food Drug Act was passed by Congress.

Importance: These laws are made to protect public health and prevent fraud in the sale of food and drugs.

Pictures:



Commercial

School made

Materials:	Ground coffee	Tripod
	Beaker glass	Can of peas
	Water	Butter
	Hydrocloric acid	Spoon
	New iron nail	Table salt
	Pan	Jar
	Bunsen burner	

Approximate Cost: Fifty cents.

Procedure: A. (Test for coffee) Spread a half teaspoonful of the coffee over the water in the glass. Leave for a few minutes.

B. (Test for canned goods) Put into the beaker a teaspoonful of mashed peas, two teaspoonsful of water, twenty drops of hydroeloric acid, and the iron nail. Set beaker in pan of water and boil ten minutes. Keep stirring the mixture.

C. (Test for butter) Place a small piece of butter in the spoon and hold it over the flame.

Comparison: No commercial product.

Topic: Health and Food.

Object: To show how carbon dioxide aids in the making of food.

Importance: Carbon dioxide gives sparkle and a pleasant biting taste to soda water, beer, mineral water, and other bubbly drinks. It is also an aid in baking by making the food rise.

Pictures:

Commercial   School made

Materials: Glass
Dish
Water
Baking soda
Spoon

Approximate Cost: None.

Procedure: Pour four heaping teaspoons of baking powder into the glass. Set it in the dish. Add enough water to moisten the baking powder thoroughly and then stir. Very soon the chemical reaction starts and the "soda fountain" will flow over the sides and run down the stem of the glass into the dish.

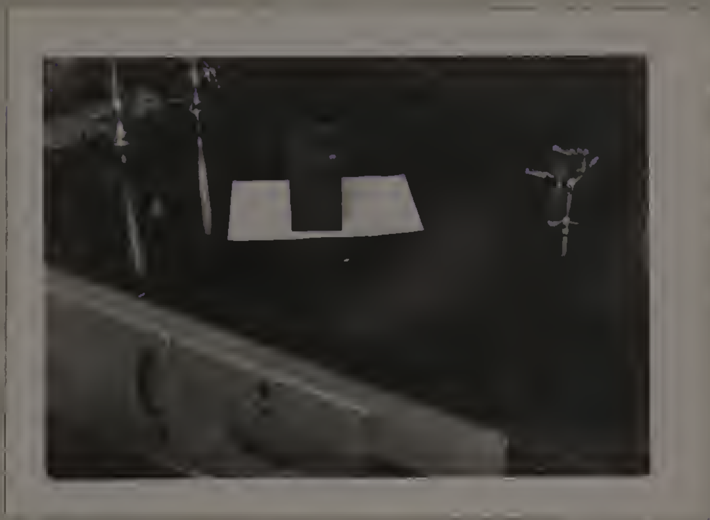
Comparison: One can't actually see the action of carbon dioxide gas in baking, but through this experiment the chemical reaction can be seen.

Topic: Light.

Object: To show how a camera functions.

Importance: By means of a camera the fastest motion and the farthest depths of space can be explored, also, the invisible world of microbes and molecules can be penetrated.

Pictures:



Commercial

School made

Materials: Cereal box
Tinfoil
Candle

Approximate Cost: None.

Procedure: Find an empty box, a candle and some tinfoil. Cut a hole one inch square in the bottom of the box. Paste the tinfoil over this hole. Prick a hole in the center of the tinfoil with a pin. Cover the open end of the box with a piece of thin tissue paper or fit it with some ground glass. Place a lighted candle before the pin hole. Darken the room or put a dark opaque cloth over the head of the person performing the experiment and the paper end of the box.

Comparison: School made process shows student that picture is inverted, where as this cannot be seen when observing enclosed camera.

Topic: Light.

Object: To show how to measure light intensity with school made photometer.

Importance: The photometer is a device that measures the strength of one light by comparing it with another of known strength.

Pictures:

Commercial School made

Materials: Two blocks of paraffin

One square of tin foil

Ruler

Approximate Cost: Twenty cents.

Procedure: Cut two blocks of paraffin from ordinary paraffin of the type used for home canning; make them of equal size and approximately square. Warm one of the faces of each block and press between these warmed faces a smooth piece of tin foil. When the wax has cooled, the two blocks and the tin foil form a solid unit. The intensity of light can be compared by putting this block between two lights in a dark room. The brightness of each light can be determined by the brightness on the edges of the blocks.

Comparison: The commercial and school made product produce the same results.

Topic: Light.

Object: To show that the colors of the spectrum come from white light.

Importance: Color plays an important part in every day life, in clothing, interior decoration, art, advertisement, and in many other ways.

Pictures:

Commercial   School made

Materials: Card board   Color pencils

Motor

Approximate Cost: None.

Procedure: Cut out a circular disk about eight inches in diameter. Make seven triangles on paper with the center of the paper as the tip of all triangles. Color in the triangles with the seven colors of the spectrum. Attach disk to shaft of a motor and allow it to spin very fast.

Comparison: The commercial and school made product produce the same results.

Topic: Transportation.

Object: To show the principle of why a sub dives and surfaces.

Importance: A submarine floats on top of water because its ballast tanks are filled with air. By opening the ballast tanks, sea water forces out the air and the sub becomes heavier and submerges. This principle can be shown with the cartesian diver.

Pictures:

Commercial

School made

Materials: Tall jar
Water
Vial

Approximate Cost: None.

Procedure: Fill glass almost to the top and place empty vial in the water; allow just enough water into vial or small bottle so that it barely floats in upside down position. Cover the tall glass with the hand and apply pressure. Applying pressure will cause the vial to sink. Release pressure and the glass rises again.

Comparison: The commercial and school made product produce the same results.

Topic: Transportation.

Object: To show the principle of the jet engine.

Importance: To assist planes to take off speedily and in a relatively small space.

Pictures:

Commercial

School made

Materials: Soap dish
Tooth powder can
Candle

Candle
Four pipe cleaners

Approximate Cost: Ten cents.

Procedure: Punch a small hole in the top and back of the can with a needle. Mount the can so that it will stand on the pipe cleaners. Half fill the can with water and replace the cover. Now place this boiler over the candle which is fast to the soap dish which is floating in the sink full of water.

Comparison: Ordinary schools would not find it feasible to have such an engine as part of equipment because of size. By this simple school made product it is possible to demonstrate the principle of the jet engine.

Topic: Transportation.

Object: To show the principles of jet engines.

Importance: The jet engine has enabled man to fly at much greater speeds than could have been possible before. At the present time jets are used primarily in fighter and bomber air craft.

Pictures:

Commercial

School made

Materials: Balloon
Paper clips
Cardboard
Four empty spools
Two round pencils

Approximate Cost: None.

Procedure: Cut a piece of cardboard so that it will ride on the pencils between the spools. Hold the cardboard to the axle (pencils) with paper clips. Place another paper clip outside of each spool so that the wheels will not fall off. Tie the balloon across the cardboard and hold the balloon on with paper clips. Inflate the balloon and let it go.

Comparison: Ordinary schools would not find it feasible to have such an engine as part of equipment because of size. By this simple school made product it is possible to demonstrate the principle of a jet engine.

Topic: Weather.

Object: To show the effect of atmospheric pressure upon a mercury barometer.

Importance: The barometer has made possible the modern science of forecasting the changes in the weather for days ahead.

Pictures:

Commercial   School made

Materials: Wide cup   Glass tubing

Mercury

Approximate Cost: None.

Procedure: Carefully fill the tube with mercury, using a medicine dropper for the purpose. Placing the thumb or first finger tightly over the open end of the tube, invert it in the dish of mercury and then slowly remove the thumb or finger.

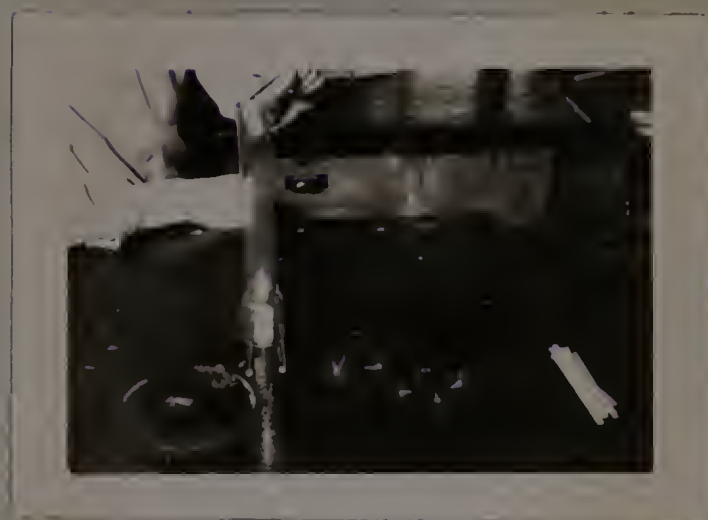
Comparison: Commercial product will be much more sensitive and accurate.

Topic; Weather.

Object: To show how a "storm center" is formed.

Importance: By predicting the path of coming storm centers, the weather bureau can save human life and millions of dollars of damage.

Pictures:



Commercial	School made

Materials: Lamp chimney — Candle

Several pencils — Sticks

Approximate Cost: None.

Procedure: Light a small candle. Place the chimney down over the candle resting it upon the pencils so that it does not touch the table. Light the sticks. Hold one over the top of the chimney. Note the direction of the smoke. Hold the hand over the top of the chimney. Note the heat. Now place the second burning stick near the bottom of the chimney. Note the direction of its smoke. Move the stick entirely around the base of the chimney. What evidence is there that air was rising from the chimney?

Comparison: No commercial product.

Topic: Weather.

Object: To show that black objects absorb more heat than white objects.

Importance: This is of great importance in the heating of homes and determing the type of clothing a person wears in the various seasons.

Pictures:

Commercial   School made

Materials: Two cans   Two boards

Two thermometers   Water

Approximate Cost: None.

Procedure: Fill two cans, one bright, the other blackened, with water at the same temperature. Cover each with a piece of wood. Put both cans in the direct rays of the sun. Take temperature of the water every five minutes.

Comparison: The greater sensitivity of the regulation product is offset by the greater durability of the school made one.

Topic: Weather.

Object: To show the principle of condensation.

Importance: Condensation is the process in which a substance changes from a vapor into a liquid. It is this principle that is used in the distillation of water and in the water cycle.

Pictures:

Commercial School made

Materials: Can Water

Ice

Approximate Cost: None.

Procedure: Fill the can two-thirds full of water and add enough ice to fill the can. Place it on a tripod. Watch the results. What can be noted on the sides of the can after a few minutes? Could the moisture come from within?

Comparison: The commercial and school made product produce the same results.

Topic: Weather.

Object: To show how the relative amount of water in the air is determined by the use of a hygrometer.

Importance: Humidity affects the health and comfort of the individual. A person feels "sticky" and uncomfortable when the humidity is too high, for the perspiration of the skin does not evaporate easily, but too little humidity is bad for the health.

Pictures:

Commercial

School made

Materials: Two thermometers
Thread
Muslin
Water

Approximate Cost: None.

Procedure: In using the two Fahrenheit thermometers wrap a small piece of muslin about the bulb of one thermometer and tie it with thread. Wet the muslin. At the beginning of the demonstration take the reading of both thermometers. Do so again after fanning the wet bulb for a few moments. Be sure that it has fallen to its lowest point. Now consult the Relative Humidity Table and follow the instructions accompanying it.

Comparison: Both the commercial and school made product produce the same results.

TABLE III

USING THE HOME AS A SOURCE OF CHEMICALS

FOR SCIENCE TEACHING

Table III

Using the Home As a Scource of Chemicals for Science Teaching

Science books, articles, and courses of study mention many different chemicals to be used in experiments and demonstrations by the teacher. Usually they are given their scientific names and the teachers and pupils may think that these chemicals are not available. However, the household contains many useful chemicals in the kitchen and in the medicine chest. Below is a typical list of common chemical substances used in science with their common household names.

SCIENTIFIC NAME	COMMON HOUSEHOLD NAME
Sodium bicarbonate	Baking soda (Bicarbonate)
Sodium carbonate	Washing soda
Ethyl alcohol	Pure rubbing alcohol
Potassium alum	Alum
Sodium tetraborate	Borax
Caustic soda, sodium hydroxide	Lye (dangerous)
Calcium carbonate	Chalk, marble, plaster
Magnesium sulphate	Epsom salts
Sodium thiosulphate	Photographer's hypo
Calcium hydroxide	Limewater
Hydrogen peroxide	Peroxide water
Acetic acid	Vinegar
Sodium nitrate	Saltpeter (do not heat)

Calcium hydroxide	Slaked lime
Sucrose	Beet sugar
Glucose	Karo syrup
Silicon dioxide	Sand
Aluminum oxide	Pure clay
Iron oxide	Rust, iron ore
Sodium chloride	Table salt
Sodium hypochlorite	Clorox
Carbohydrate	Starch or sugar
Starch	Corn starch or flour
Dextrose	Grape or fruit sugar
Lactose	Milk sugar
Acetone	Nail polish remover (some)
Lugol's solution	Tincture of iodine, one part to 100 parts of water

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

Today, we are living in an environment made complex through the contributions of scientific research. This is affecting trends in education and particularly trends in science education.

There seems to be no argument against the idea that science has made it possible for our country to produce automobiles, telephones, radios, television, and other modern conveniences, thereby elevating the standard of living. It is a logical conclusion that, for the men and women of the coming generation to have even more conveniences, it is necessary that great numbers of our youth be given science instruction so as both to produce and use such products.

Laboratory exercises or experiments by the pupil have long been one part of the conventional way of teaching science. For pupils preparing for college entrance, it is fairly universal; but, even for general education pupils, it is a very effective way of learning. Learning by doing is clearly recognized as more effective than learning by reading.

A good science teacher can work to develop a balanced experimental program where pupils can work individually or collectively on personal and local problems. A well- prepared teacher should be able to contribute many inexpensive ideas and to stimulate pupils to bring useful equipment from home. Pupils are willing and usually eager to bring simple items that can be used in teaching science.

The results of carrying on these experiments proved quite definitely that the problem of the expense involved can be solved to a great extent if one is willing to put time and effort into finding or arranging inexpensive substitutes for costly equipment.

Practically all of the materials that were used for the experiments in this problem were donated by various people in town. When the members of the community realized that the materials were going to be used by the school children for school projects, they were more than willing to donate the material. The amount of saving in a project of this type can well be seen by checking the cost of the school made projects. This information can be found in Table IV.

The fact that almost all of these demonstrations were performed with equipment usually found about the house or with materials which could be bought at the local stores, provided an added stimulus for the more interested students.

Incidentally, this project also presented a splendid opportunity for inter-faculty cooperation. Not only did it allow one to work with others in his own department, but also provided an opportunity to gain the cooperation of some other members of the teaching staff, as well as the enthusiastic help of some of their students.

Experimentation is valuable to the child in a general science course, not only because it enables him, by seeing and taking part, to understand better the scientific principles illustrated by the experiment, but also because it affords him pleasurable experiences. It is said that students usually do best what they enjoy doing. That the pupils enjoyed performing these experiments was vividly illustrated by the enthusiasm of the young people whose pictures are included in this paper.

The results of this project were gratifying, far beyond the original concept of the experiment. It demonstrated that an adequate basic course in general science could be taught without the use of expensive equipment. It created an unusually co-operative spirit between teacher and students, and among the students themselves. More important, perhaps, was the development of the creative abilities of the pupils in contrast to the usual "spoonfed" type of course, putting it in line with the "do it yourself" trend, now sweeping the country. Most important of all, it gave the student a taste of the joy of independent research, which is fundamental to all true education and its advancement.

TABLE IV

COST OF COMMERCIAL AND SCHOOL MADE PRODUCT

TABLE IV

COST OF COMMERCIAL AND SCHOOL MADE PRODUCT

TOPIC	EQUIPMENT	BOUGHT	MADE
Air	Barometer	$30.00	$1.00
Air	Air pump and bell jar	85.00	0
Air	Sports	0	.10
Air	Sprayer	4.50	.10
Air	Collapsible can	.75	0
Air	Model plane	0	0
Air	Hemisphere	2.95	.10
Heat	Convection box	4.70	.20
Heat	Radiometer	6.50	.50
Heat	Ball and ring	2.25	.10
Heat	Hot and cold air weight	5.50	0
Heat	Conductometer	2.75	0
Fire	Fire blanket	34.00	1.00
Fire	Fire extinguisher	15.50	.10
Fire	Fire extinguisher	13.50	.50
Fire	Fire blanket	34.00	0
Water	Liebig apparatus	5.15	.20
Water	Osmosis	2.95	.20
Water	Town water system	0	0
Elec. & Mag.	Galvanometer	4.75	.20
Elec. & Mag.	Electro-generator	17.50	.50
Elec. & Mag.	Static machine	120.50	0
Elec. & Mag.	Electric motor	27.00	1.00
Elec. & Mag.	Electroscope	7.50	.20

TOPIC	EQUIPMENT	BOUGHT	MADE
Elec. & Mag.	Compass	$ 1.45	$ 0
Elec. & Mag.	Electro-magnet	5.25	.10
Elec. & Mag.	Electrophorous	6.00	.20
Elec. & Mag.	Telegraph set	8.25	.10
Sound	Trombone	0	0
Sound	Stringed instrument	0	0
Sound	Telephone	6.00	0
Sound	Guitar	0	.20
Health & Food	Convection apparatus	4.75	.50
Health & Food	Soap	.12	.15
Health & Food	Pasteurization	4000.00	0
Health & Food	Testing food	0	.50
Health & Food	Carbon dioxide	0	0
Light	Camera	9.85	0
Light	Photometer	8.00	.20
Light	Spectrum	1.45	0
Transportation	Submarine	1.50	0
Transportation	Jet engine	0	0
Transportation	Jet engine	0	0
Weather	Mercury barometer	15.00	0
Weather	Storm center	0	0
Weather	Radiometer	5.50	0
Weather	Condensation	5.15	0
Weather	Hygrometer	8.00	0

APPENDIX I

AUTHOR'S NOTE OF APPRECIATION

APPENDIX I

AUTHOR'S NOTE OF APPRECIATION

The author wishes to express his appreciation to the following persons, without whose cooperation this study would not have been possible:

Paul Bourdeau

George Bush

Louis Bush

Jack Collins

William Connolly

Cyril Desautel

Theodore Farwell

Charles Galvin

Mrs. Olaff Hoff

James McDonnell

Richard Putnam

George Richason

Alice Teed

Elizabeth Withington

George Wrightson

Raymond Wyman

BIBLIOGRAPHY

BIBLIOGRAPHY

Beauchamp, Wilbur, Mayfield, John, West, Joe. Everyday Problems in Science. New York: Scott, Forman, and Company, 1940.

Blough, Glenn O. Elementary Science Series. Washington: U.S. Government Printing Office, 1947.

Brandwein, Paul, Hollingworth, Leland, Burgess, Anna. Science for Better Living. New York: Harcourt, Brace and Company, 1950.

Brandwein, Paul. "Trends in High School General Science". The Bulletin of the National Association of Secondary-School Principals. Washington D.C. National Education Association, 1953.

Bush, George, Thompson, Will. New Senior Science. Boston: American Book Company, 1941.

Craig, Gerald S. Science for the Elementary-School Teacher. New York: Ginn & Company, 1946.

Craig, Gerald S. Science in Childhood Education. New York: Bureau of Publications, Teachers College, Columbia University, 1944.

Curtis, Francis, Mallison, George. Science in Daily Life. Boston: Ginn and Company, 1953.

Curtis, Francis. A Third Digest of Investigations in the Teaching of Science. Philadelphia: Blakiston, 1939.

Davis, Ira, Burnett, John, Gross, E. Wayne. Science a Story of Discovery and Progress. New York: Henry Holt and Company, 1952.

Eby, George, Waugh, Charles, Welch, Herbert, Buckingham, Burdette. The Physical Science. Boston: Ginn and Company, 1950.

Gilman, Phil, Houten, L.F. Van. General Science Today. New York: Rand McNally and Company, 1954.

Heiss, E.D., Oburn, E.S., Hoffman, C.W. Modern Methods and Materials for Teaching Science. New York: Mac-Millian, 1940.

Hoff, Arthur, *Secondary School Science Teaching*. Philadelphia: The Blakiston, 1947.

Johnson, Philip. "The Teaching of Science in Public High Schools". *Federal Security Agency Bulletin*. Washington D.C. Office of Education, 1950.

Laton, Anita, Powers, Samuel. *New Directions in Science Teaching*. New York: McGraw-Hill Company Inc., 1949.

Mulhern, James. *A History of Education*. New York: The Ronald Press Company, 1946.

National Society for the Study of Education. Thirty-first Yearbook. Part I. *A Program for Teaching Science*. Bloomington, Ill., Public School Publishing Co., 1932.

N.S.S.E. Forty-sixth Yearbook, Part I. *Science Education in American Schools*. Chicago: University of Chicago Press, 1947.

Noll, Victor. *The Teaching of Science in Elementary and Secondary Schools*. New York: Longmans and Green, 1939.

Parker, Bertha. *Science Experiences*. Evanston, Ill. Row, Peterson and Company, 1952.

Progressive Education Association. Commission on Secondary School Curriculums. *Science in General Education*. New York: Appleton-Century, 1937.

Publication of the Laboratory Schools. *Science Instruction in Elementary and High School Grades*. Chicago: The University of Chicago, 1939.

Slavson, S., Speer, R. *Science in the New Education*. New York: Prentice Hall, 1934.